DECLARATION

I, Kazumi ITO, a subject of Japan residing at 3-1-3-509, Shakujiidai, Nerima-ku, Tokyo, 177-0045 Japan, solemnly and sincerely declare:

That I have thorough knowledge of Japanese and English languages; and

That the attached pages contain a correct translation into English of the specification of the following Japanese Patent Application:

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I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 28th day of March, 2007

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[Title of the Invention] IMAGE PROCESSING APPARATUS AND METHOD AND PROGRAM STORAGE MEDIUM

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[Title of the Invention] IMAGE PROCESSING APPARATUS AND METHOD AND PROGRAM STORAGE MEDIUM

[Claims]

[Claim 1] An image processing apparatus comprising:

image input means for inputting an image;

image attached information input means for inputting information attached to the image input by the image input means;

face detection means for detecting a face from the image input by the image input means;

face-detection angle-range determination means for determining an angle range used in a process of detecting a face from the input image on the basis of the image attached information input by the image attached information input means; and

process control means having a mode to control the execution of the face detecting process on the basis of information regarding the angle range determined by the angle-range information determination means.

[Claim 2] The image processing apparatus according to Claim 1, wherein the process control means controls the execution of the face detecting process in predetermined angle increments.

[Claim 3] The image processing apparatus according to

Claim 1 or 2, further comprising:

rotation means for rotating an image,

wherein the process control means allows the rotation means to rotate the input image in order to form images in predetermined angle increments, and performs the face detecting process on the respective images.

[Claim 4] The image processing apparatus according to Claim 1 or 2, further comprising:

reference data conversion means for converting face detection reference data used for face detection into reference data for a tilted face,

wherein the process control means allows the reference data conversion means to convert the face detection reference data into reference data for a tilted face in order to generate tilted-face reference data in predetermined angle increments, and executes the face detecting process on the input image using the generated tilted-face reference data.

[Claim 5] A method for processing an image, comprising:

an image input step of inputting an image;

an image attached information input step of inputting information attached to the image input in the image input step;

a face detection step of detecting a face from the image input in the image input step;

a face-detection angle-range determination step of determining an angle range used in a process of detecting a face from the input image on the basis of the image attached information input in the image attached information input step; and

a process control step having a mode to control the execution of the face detecting process on the basis of information regarding the angle range determined in the angle-range information determination step.

[Claim 6] The method according to Claim 5, wherein in the process control step, the execution of the face detecting process is controlled in predetermined angle increments.

[Claim 7] The method according to Claim 5 or 6, further comprising:

a rotation step of rotating an image,

wherein in the process control step, images are formed in predetermined angle increments by rotating the input image in the rotation step, and the face detecting process is performed on the respective formed images.

[Claim 8] The method according to Claim 5 or 6, further comprising:

a reference data conversion step of converting face detection reference data used for face detection into reference data for a tilted face,

wherein in the process control step, tilted-face

reference data is generated in predetermined angle increments by converting the face detection reference data into reference data for a tilted face in the reference data conversion step, and the face detecting process is performed on the input image using the generated tilted-face reference data.

[Claim 9] A computer-system executable program which allows a computer system for executing the program to operate as the image processing apparatus according to any one of Claims 1 to 4.

[Claim 10] A computer-program storage medium in which a computer program is stored, the program realizing the image processing method according to any one of Claims 5 to 8 and indicating an operating procedure of steps included in the method.

[Claim 11] A computer program realizing the image processing method according to any one of Claims 5 to 8 and indicating an operating procedure of steps included in the method.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an image processing apparatus and method mainly used to determine whether an image to be processed is obtained by photographing a person

as a primary subject, the apparatus and method for detecting the face of a person included in an image read by an image input device, such as an imaging device.

[0002]

[Description of the Related Art]

Imaging devices, particularly, digital still cameras (hereinbelow, referred to as digital cameras), which are being widely spread recently, each include various image processing functions: an exposure adjustment mechanism called AGC (Auto Gain Control) for assigning a subject brightness threshold to the dynamic range of an imaging device on the basis of image signals taken by the imaging device comprising a CCD or a CMOS sensor; a tone adjustment mechanism called AWB (Auto White Balance) for correcting the tone of a subject to a proper tone; a gamma conversion mechanism for adjusting a change in gray scale and contrast; a noise removal mechanism; and an edge enhancement mechanism.

[0003]

As described in Japanese Patent Laid-Open Nos. 2000-123164 and 2000-123165, processes for captured image signals are being put into intelligence.

[0004]

Japanese Patent Laid-Open No. 2000-123164 describes that change of a process or a conversion level in accordance with the features of an image is more preferable than

execution of a predetermined process without consideration of the features of the image. Japanese Patent Laid-Open No. 2000-123165 discloses correction with emphasis on a primary subject of an image, namely, image correction appropriate to the primary subject. Particularly, as for a portrait including a person as a primary subject, in displaying a captured image on a display screen or printing the image as a hard copy output through a color printer to obtain a reproduced image, when various image enhancement processes or image correction processes such as color reproduction for the skin tone of the person and contrast control are different from those for other images, a person viewing the reproduced image receives a good impression. This fact is being known.

[0005]

For methods for extracting the face of a person, included in a captured image, from the image, several methods are disclosed. For example, Japanese Patent Laid-Open No. 2001-309225 discloses a method for detecting a face using a first face candidate detection algorithm and a second algorithm. The first face candidate detection algorithm uses a pattern recognition operator for detecting a central part which may probably include the skin of a subject person on the basis of colors and shapes and detecting surrounding areas which may probably include the

hair thereof on the basis of the colors and shapes to detect an area (face candidate area) which may probably include the face thereof. The second algorithm uses pattern matching to detect the presence of the face in the face candidate area obtained by the first algorithm.

[0006]

Japanese Patent Laid-Open No. 8-63595 discloses the following methods. According to a first method, the edge of a skin tone area is extracted on the basis of colors, and the extracted edge is compared to a prepared face edge template to obtain the degree of matching. On the basis of the degree of matching, a face is detected. According to a second method, an eye candidate area is obtained and is compared to an eye template to obtain the degree of matching. On the basis of the degree of matching, a face is detected. According to a third method, a face candidate area obtained using a face edge template is subjected to two-dimensional Fourier transform, prepared face template images each including eyes, a nose, a mouth, and hair are subjected to two-dimensional Fourier transform, the amount of features to be defined is obtained on the basis of the above two-dimensional Fourier transform results, and the amount of features is subjected to a threshold process, thus detecting a face.

[0007]

Japanese Patent Application No. 2001-282283 discloses the following method: An eye candidate area is obtained. When a plurality of eye candidates are found, annular areas are arranged in the vicinities of an arbitrary pair of eye candidates so as to correspond to the respective eye candidates. On the basis of the directional difference between a predetermined reference gradient and a gradient in pixel value between each pixel in the annular area and each of the neighboring pixels, a face is detected.

[0008]

Recent digital cameras each have an angle (inclination) sensor therein. The angle sensor detects the photographing position of the camera (the camera is held longitudinally or laterally, or how much is the camera rotated from a reference position) held when an image is captured. The photographing position is set to information attached to the image. The digital camera outputs the image together with the photographing-position information as image attached information. This type of digital cameras appear on the market.

[0009]

[Problems to be Solved by the Invention]

General face detection methods including the above-described methods for extracting the face of a person are performed on the precondition that a face to be detected is

photographed such that the face of a person in an upright position is fundamentally included in an image frame. Accordingly, the orientation of the face which can be detected is restricted.

[0010]

However, for captured images, particularly, images captured by digital cameras, a photographer holds a camera freely, for example, longitudinally, laterally, or tilts the camera in some cases. In addition, the position of a subject person is not always upright such that the whole face is photographed like a photograph for an ID card. The person may slightly tilt his or her face and he or she may be lying. Various positions can be expected.

[0011]

Accordingly, a face may be freely photographed at various angles with respect to the image frame, fundamentally, in an angle range of 360 degrees. In order to detect a face at any angle, therefore, it is necessary to repeat a process of detecting a face from an image, obtained by rotating an original image, in predetermined angle increments, the predetermined angle being a reference angle range in which the face detecting process can be performed. Alternatively, it is necessary to prepare templates for pattern matching and various amounts of features used in face detection so as to correspond to all of predetermined

angles and execute a face detecting process at each of the predetermined angles. In order to detect a face from a snapshot captured by a digital camera, these methods require detection time proportional to the number of times of the detecting process repeated in predetermined angle increments.

[0012]

The present invention is made in consideration of the above-mentioned disadvantages of the related art. It is an object of the present invention to provide an image processing apparatus and method for detecting the face of a person included in a captured image at higher speed, and a program storage medium.

[0013]

[Means for Solving the Problems]

According to the present invention, there is provided an image processing apparatus including: image input means for inputting an image; image attached information input means for inputting information attached to the image input by the image input means; face detection means for detecting a face from the image input by the image input means; face-detection angle-range determination means for determining an angle range used in a process of detecting a face from the input image on the basis of the image attached information input by the image attached information input means; and process control means having a mode to control the execution

of the face detecting process on the basis of information regarding the angle range determined by the face-detection angle-range information determination means.

[0014]

According to the present invention, there is provided a method for processing an image, including: an image input step of inputting an image; an image attached information input step of inputting information attached to the image input in the image input step; a face detection step of detecting a face from the image input in the image input step; a face-detection angle range determination step of determining an angle range used in a process of detecting a face from the input image on the basis of the image attached information input in the image attached information input step; and a process control step having a mode to control the execution of the face detecting process on the basis of information regarding the angle range determined in the face-detection angle range information determination step.

[0015]

[Embodiments]

Preferred embodiments of the present invention will be described in detail below with reference to the accompanying drawings.

[0016]

[First Embodiment]

Fig. 1 is a functional block diagram according to a first embodiment of the present invention. Image input means 20 includes image capture means 21, such as an interface circuit for capturing image data taken by a well-known digital camera, and an image memory 7 for holding the captured image data. The image input means 20 acquires image data obtained by photographing a scene including a primary subject. The image data acquired by the image input means 20 is output as digital image data to face detection means 30.

[0017]

Photographing-position information input means 50 captures attribute data attached to an image input by the image input means 20 through the interface circuit in the same way as the image data. When photographing-position information is included in the attribute data attached to the image, the photographing-position information input means 50 extracts this information and then supplies the extracted information to angle-range information determination means 60. The angle-range information determination means 60 determines an angle range, in which a face should be detected from the image to be processed, on the basis of the information obtained from the photographing-position information input means 50, and outputs information regarding the determined angle range to

process control means 70. The process control means 70 controls the face detection means 30 to execute a face detecting process on the basis of the angle-range information determined by the angle-range information determination means 60.

[0018]

The face detection means 30 receives an image from the image memory 7 of the image input means 20. In the face detection means 30, under the control of the process control means 70, image rotation means 31 rotates the image by a predetermined angle of rotation to form an image and an image memory 9 holds the formed image. Basic-angle-range face detection means 32 executes a process of detecting a face from the image, stored in the image memory 9, in a basic angle range (for example, according to the method disclosed in Japanese Patent Application No. 2001-282283, a basic angle range is set to about ± five degrees so as to include the front surface of a primary subject standing upright and the following description for the present embodiment will be made on condition that the above-mentioned angle range of ten degrees is set to the basic angle range). When a face is detected in this range, the face detection means 30 outputs face data to face integration means 33.

[0019]

Under the control of the process control means 70, on the basis of the angle-range information, the image rotation means 31 rotates the image the necessary number of times to form images (rotation images), and the basic-angle-range face detection means 32 repeats the process of detecting a face from each rotation image the necessary number of times while changing an angle of rotation in predetermined angle increments (for example, according to the method disclosed in Japanese Patent Application No. 2001-282283, the angle is about 10 degrees and the present embodiment will be described on condition that the rotation angle is changed in 10 degree increments) based on a face detectable angle of the basic-angle-range face detection means 32. The basic-angle-range face detection means 32 outputs images detected from the respective rotation images to the face integration means 33. The face integration means 33 integrates face data detected from the respective rotation images into face information and then outputs the face information as a unit, the face information including all of the face data detected from the image input by the image input means 20.

[0020]

Fig. 2 is a schematic block diagram of the arrangement of a system realizing the embodiment shown in Fig. 1. The system shown in Fig. 2 includes a bus 1. An input I/F (interface) 2 constitutes the image capture means 21 of the

image input means 20 and the photographing-position information input means 50 in Fig. 1. An output interface 3 outputs a high-quality image, obtained by the application of the face detecting process, to a printer. A communication I/F 5 communicates with an external device arranged outside of the system shown in Fig. 2 via a network. The image memories 7 and 9 hold images to be processed for face detection. The image memory 7 corresponds to the image input means 20 and holds input image data. The image memory 9 holds images formed by rotating the input image through the image rotation means 31.

[0021]

The system further includes a CPU 6, a RAM 8, a ROM 10, and an I/O (input/output circuit) 4 for receiving data and transmitting data from/to a hard disk drive 11. An imaging device 12, such as a digital camera, supplies image data and data attached to the image data to the image input means 20. A printer 13 prints an output image.

[0022]

The above components 1 to 11 constitute the computer system. This computer system has the arrangement realizing the functional blocks: the image capture means 21 in the image input means 20, the image rotation means 31 and the basic-angle-range face detection means 32 and the face integration means 33 in the face detection means 30, the

photographing-position information input means 50, the angle-range information determination means 60, and the process control means 70.

[0023]

The operation according to the present embodiment will now be described with reference to a flowchart of Fig. 3. In step S10, a target image to be processed is supplied from the imaging device 12, such as a digital camera, to the image memory 7 via the input I/F 2 to store the image in the image memory 7. The operation proceeds to step S20.

[0024]

In step S20, data (hereinafter, also referred to as image attached information) attached to the image is supplied from the imaging device 12, such as a digital camera, to the RAM 8 via the input I/F 2 to store the data in a predetermined area (not shown) in the RAM 8. The operation proceeds to step S30.

[0025]

In step S30, whether significant photographing-position information is included in the image attached information stored in the predetermined area (not shown) in the RAM 8 in step S20 is determined. If significant photographing-position information is included, the operation proceeds to step S40. If NO, the operation proceeds to step S80.

[0026]

Whether the image attached information includes significant photographing-position information can be determined by checking information written in a predetermined area of the image attached information. In this case, when a value of 0 is written, there is no significant photographing-position information. When a value in the range of 1 to 360 is written, the image attached information includes significant photographing-position information.

[0027]

An example of attached information will now be described with reference to Figs. 6 to 8. Fig. 6 shows an example of an image photographed when a photographer holds a camera in the normal position (namely, he or she holds the camera without rotating it). That is, Fig. 6 shows the image obtained by photographing a person in an upright posture as a subject. At this time, a value indicating that the upright posture can be recognized as an upright position is written in the predetermined area, in which photographing-position information should be stored, in the image attached information. In this case, it is assumed that a value of 360 is written.

[0028]

Fig. 7 shows examples of an image photographed when the photographer rotates the camera counterclockwise by 90

degrees and longitudinally holds the camera so as to take a vertically oriented picture (in other words, when a subject person looks this camera, the camera is rotated clockwise by 90 degrees). (a) in Fig. 7 shows the image obtained by photographing the person in an upright posture as a subject. (b) in Fig. 7 shows the photographed image on the assumption that the subject is photographed without rotating the camera. At this time, a value indicating that the horizontally oriented image with a head at the right can be recognized as an upright position is written in the predetermined area, in which the photographing-position information should be stored, in the image attached information. In this case, it is assumed that a value of 270 is written.

[0029]

Fig. 8 shows examples of an image photographed when the photographer rotates the camera clockwise by 90 degrees and longitudinally holds the camera so as to take a vertically oriented picture (in other words, when a subject person looks this camera, the camera is rotated counterclockwise by 90 degrees). (a) in Fig. 8 shows the image obtained by photographing the person in an upright posture as a subject. (b) in Fig. 8 shows the photographed image on the assumption that the subject is photographed without rotating the camera. At this time, a value indicating that the horizontally oriented image with a head at the left can be recognized as

an upright position is written in the predetermined area, in which the photographing-position information should be stored, in the image attached information. In this case, it is assumed that a value of 90 is written.

[0030]

In step S40, on the basis of the photographing-position information obtained in step S30, an angle range in which face detection should be performed is determined. The determined angle range is set as angle-range information in a predetermined area in the RAM 8. Specifically speaking, a set of values, obtained by adding 90 to a value indicating the photographing-position information obtained in step S30 and subtracting 90 from the above value, are stored in the predetermined area in the RAM 8. In the case of Fig. 7, since 270 ± 90, values of 180 and 360 are set. In the case of Fig. 8, since 90 ± 90, values of 0 and 180 are set. In the case of Fig. 6, since 360 ± 90, values of 270 and 450 are set. If step S40 is completed, the operation proceeds to step S50.

[0031]

In step S80, values of 0 and 360 are set as angle-range information in the predetermined area in the RAM 8. If the process of step S80 is completed, the operation proceeds to step S50.

[0032]

In step S50, on the basis of the angle-range information set in step S40 or S80, the process of detecting a face from an image (rotation image) formed by rotating the image every predetermined angle is repeated in the angle range while the angle of rotation is being changed in predetermined angle increments (for example, an angle of about ten degrees is used in the method disclosed in Japanese Patent Application No. 2001-282283 and the description of the present embodiment will be continued on condition that the rotation angle is changed in 10 degree increments) based on the face detectable angle held by the basic-angle-range face detection means 32. All of face data detected from the respective rotation images are output to another predetermined area in the RAM 8. If the face detecting process in the angle range is terminated, the operation proceeds to step S60. The process of step S50 will be described in detail later.

[0033]

In step S60, if the face data includes overlaps, the face data being detected in the process performed every predetermined angle in the angle range in step S50, the overlapping data is eliminated. In addition, if a plurality of different pieces of face data are remaining, those pieces of face data are integrated into data detected from one input image. The integrated data is stored in a

predetermined area in the RAM 8. The operation proceeds to step S70.

[0034]

In step S70, the face data stored in the RAM 8 in step S60 is stored as new attached information in the hard disk drive via the I/O 4 together with the input image data. Alternatively, the face data is output via the communication I/F 5 to another external system, which is operatively associated with the imaging device 12. Alternatively, the face data is transmitted to another process which is executed in the computer system shown in Fig. 2. After that, a series of processing steps of the operation is terminated.

[0035]

The process of step S50 will now be described in detail with reference to a flowchart of Fig. 9. Upon start of the process of step S50, in step S510, a value of a large angle of the angle-range information set in the predetermined area in the RAM 8 in step S40 or S80 is stored in a temporary buffer. The process proceeds to step S520.

[0036]

In step S520, whether the value stored in the temporary buffer is smaller than a value of a small angle of the angle-range information set in the predetermined area of the RAM 8 in step S40 or S80 is determined. If the stored value is smaller than the set value, it is determined that the

face detecting process is completed in the whole angle range and the process of step S50 is terminated. If NO, the process proceeds to step S530.

[0037]

In step S530, 180 is subtracted from the value stored in the temporary buffer. The obtained value is set as a value of the rotation angle in another predetermined area of the RAM 8. The process proceeds to step S540.

[0038]

In step S540, the value of the rotation angle set in step S530 is set to an angle to be used for a process of rotating the input image stored in the image memory 7. According to a well-known image rotation processing method (affine transformation using the center of an input image as a center of rotation), the input image is rotated to the left (counterclockwise) by the rotation angle to form an image. The formed image is stored in the image memory 9. The process proceeds to step S550.

[0039]

In step S550, the image stored in the image memory 9 is subjected to a well-known face detecting process. The detection result is output to another predetermined area in the RAM 8. The process proceeds to step S560. In this description, it is assumed that the method disclosed in Japanese Patent Application No. 2001-282283 is used as the

well-known face detecting process. The above-described other methods or other various face detecting methods can also be used.

[0040]

In step S560, a face detectable angle range (for example, an angle of about ten degrees is used in the method disclosed in Japanese Patent Application No. 2001-282283 and an angle of ten degrees will be used in the present embodiment) peculiar to the face detecting method which is currently used is set to a predetermined angle. A value of the predetermined angle is subtracted from the value stored in the temporary buffer. The obtained value is reset as a new value to be stored in the temporary buffer. The process is returned to step S520.

[0041]

As described above, if there is significant angle-range information, the number of repeating times of the face detecting process can be remarkably reduced as compared to that of a case where there is no significant angle-range information.

[0042]

[Second Embodiment]

According to the first embodiment, in step S50, the input image is rotated to form an image, the formed image is subjected to the face detecting process, and the series of

processing steps is repeated to execute the face detection in the whole of the face detection angle range. However, the present invention is not limited to this case.

[0043]

In other words, as another face detecting method, a pattern recognition method based on matching using various templates prepared fundamentally is used. The templates are used as reference data. An input image is not rotated. While the template as reference data is being changed to a template corresponding to the rotation angle every predetermined angle, the face detecting process may be executed.

[0044]

Fig. 4 is a block diagram of an image processing apparatus according to the second embodiment, the apparatus having the above-mentioned operation and functions. The second embodiment differs from the first embodiment, shown in Fig. 1, in that an input image is not rotated and reference data for pattern matching is rotated in face detection means 30. Accordingly, the image memory 9 is removed. In addition to functional blocks similar to those in Fig. 1, the image processing apparatus further includes basic-angle reference data holding means 35 for holding template data as reference data used for pattern matching, and reference data supply means 36 for performing a rotating

process on the reference data to generate reference rotation data and then providing the generated data to reference-angle-range face detection means.

[0045]

When the arrangement shown in Fig. 2 realizes the image processing apparatus including the functional blocks shown in Fig. 4, fundamentally, the operation similar to that of Fig. 3 can be performed. However, step S540 in the flowchart of Fig. 9 is changed. According to the first embodiment, the input image itself is rotated to form a rotation image in step S540. According to the second embodiment, template data as reference data used in pattern matching is rotated to generate reference rotation data in step S540, and the generated data is provided in step S550.

[0046]

In many cases, a load applied to the process of rotating reference data is smaller than that for input image data. Accordingly, the operation can be performed at higher speed.

[0047]

[Third Embodiment]

As a modification of the first and second embodiments, a third embodiment will now be described. According to the third embodiment, a dual face detecting process is executed. In other words, the following two processes can be

simultaneously performed: In a first process, an input image is rotated to form a rotation image and the formed image is subjected to the face detecting process. On the other hand, in a second process, the input image which is not rotated is subjected to a matching process using a rotated template pattern and the matched image is subjected to the face detecting process.

[0048]

Fig. 5 is a block diagram of an image processing apparatus according to the third embodiment. Differently from the first and second embodiments, both of an input image and reference data for pattern matching are rotated in face detection means 30. Accordingly, the image processing apparatus includes an image memory 9, basic-angle reference data holding means 39 for holding template data, serving as reference data used for pattern matching, and reference data supply means 40 for performing a rotating process on reference data to generate reference rotation data and supplying the generated data to reference-angle-range face detection means. Both of an input image itself and an image formed by rotating the input image are input to the basic-angle-range face detection means.

[0049]

When the arrangement shown in Fig. 2 realizes the image processing apparatus including the functional blocks shown

in Fig. 4, fundamentally, the operation similar to that of Fig. 3 can be performed. However, step S540 in the flowchart of Fig. 9 is changed. In other words, according to the first embodiment, in step S540, an input image itself is rotated to form a rotation image and template data as reference data used for pattern matching is rotated to generate reference rotation data. Both of the formed image and the reference rotation data are provided in step S550. In step S550, the face detecting process is performed on the rotation image formed by rotating the input image. Simultaneously, the input image which is not rotated is subjected to the matching process using a rotated template pattern. As described above, the two processes are simultaneously performed.

[0050]

According to the third embodiment, the face detection result can be obtained with more accuracy than that of only one face detecting process.

[0051]

[Other Embodiment]

The object of the present invention can also be accomplished as follows: A storage medium, in which program codes of software to realize the functions of a host and terminals according to any of the above-described first to third embodiments are stored, is supplied to a system or an

apparatus. A computer (or a CPU or an MPU) of the system or apparatus reads the program codes stored in the storage medium to execute the program codes. In this case, the program codes read from the storage medium realize the functions of the embodiment. The present invention includes the storage medium in which the program codes are stored.

[0052]

As a storage medium providing the program codes, a ROM, a flexible disk, a hard disk, an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, and a nonvolatile memory card can be used.

[0053]

Further, the present invention also includes the following case. Program codes read by a computer are executed to realize the functions of each embodiment. In addition, on the basis of indications of the program codes, an OS, which is running on the computer, executes a part or all of actual processes to realize the functions of each embodiment.

[0054]

Further, the present invention also includes the following case. Program codes read from a storage medium are written in a memory provided for a feature expansion board inserted in a computer or a feature expansion unit connected to the computer. On the basis of indications of

the program codes, a CPU, which is provided for the feature expansion board or feature expansion unit, executes a part or all of actual processes to realize the functions of each embodiment.

[0055]

[Advantages]

As described above, photographing-position information attached to an input image is also input, and the photographing-position information is effectively used to determine information regarding an angle range used to detect a face from the input image, serving as a face detection target, thus limiting the angle range. Consequently, a face which may be included in the image can be detected in various angle ranges at higher speed than that of the related art.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a diagram of the arrangement of functional means for solving the problems of the present invention.

[Fig. 2]

Fig. 2 is a diagram showing an example of the arrangement of a system embodying the present invention.

[Fig. 3]

Fig. 3 is a flowchart of the operation of an apparatus embodying the present invention.

[Fig. 4]

Fig. 4 is diagram showing an example of the structure of an apparatus according to a second embodiment.

[Fig. 5]

Fig. 5 is diagram showing an example of the structure of an apparatus according to a third embodiment.

[Fig. 6]

Fig. 6 shows an example of an image obtained by photographing with a camera in the normal position.

[Fig. 7]

Fig. 7 includes examples of an image obtained by photographing with a camera rotated counterclockwise by 90 degrees.

[Fig. 8]

Fig. 8 includes examples of an image obtained by photographing with a camera rotated clockwise by 90 degrees.

[Fig. 9]

Fig. 9 is a flowchart of the detailed process of step S50.

[Reference Numerals]

1: bus

2: input I/F

3: output I/F

4: I/O

5: communication I/F

6: CPU

7: image memory

8: RAM

9: image memory

10: ROM

20: image input means

30: face detection means

50: photographing-position information input means

60: angle-range information determination means

[Name of Document] ABSTRACT

[Abstract]

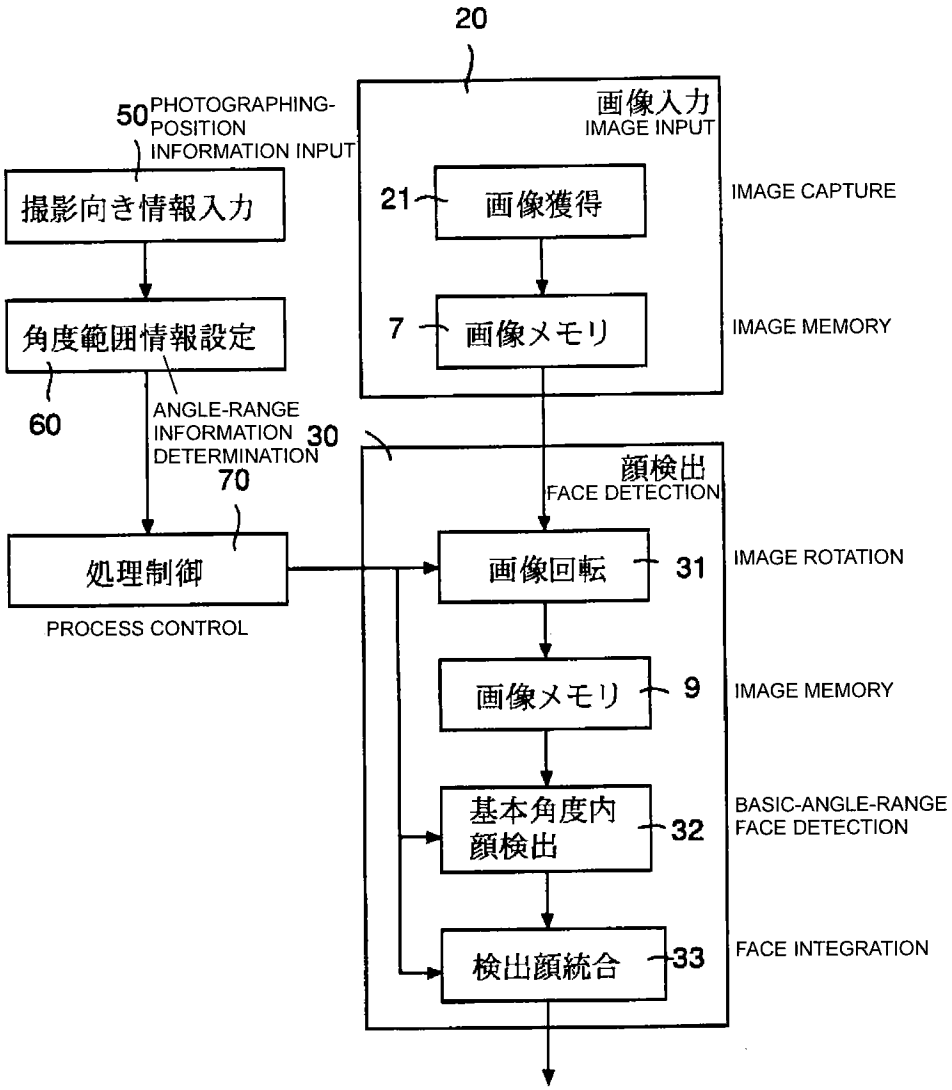
[Object] To allow for rapid detection of the face of a person.

[Solving Means] Image input means 20 inputs an image to be processed. Photographing-position information input means 50 inputs photographing-position information attached to the image. Angle-range information determination means 60 determines information regarding an angle range, where face detection should be performed on the image, on the basis of the information obtained by the photographing-position information input means 50. On the basis of the angle-range information, under the control of process control means 70, face detection means 30 performs face detection on the image input by the image input means 20 at various angles. Face integration means 33 integrates all of face data, detected by basic-angle-range face detection means, into face information and then outputs the information.

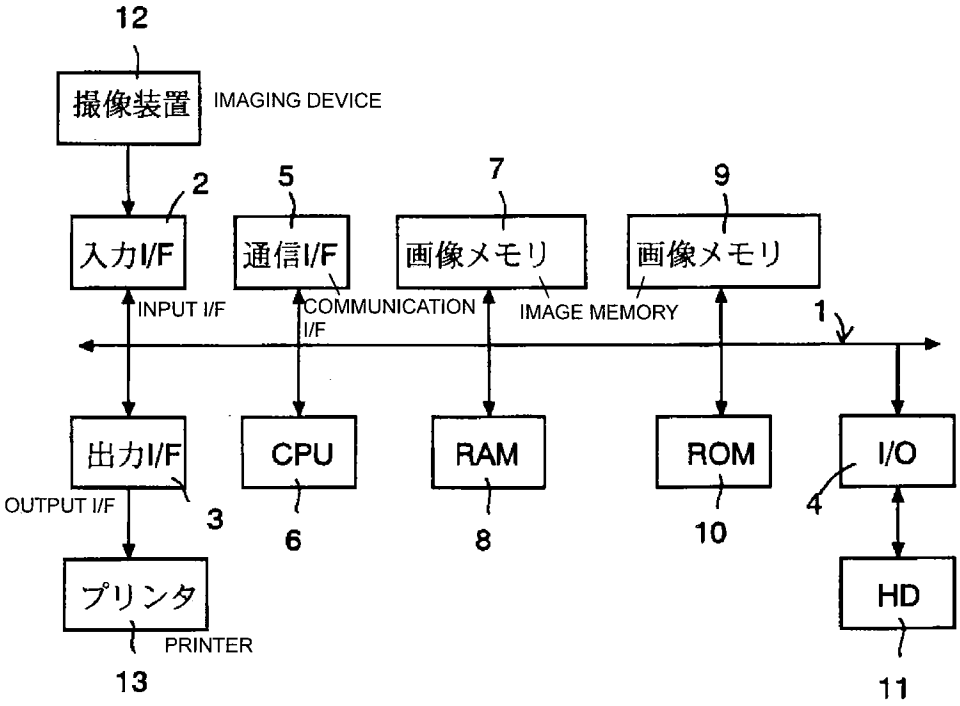
[Selected Figure] Fig. 1

【書類名】　図面　[Name of Document] DRAWINGS

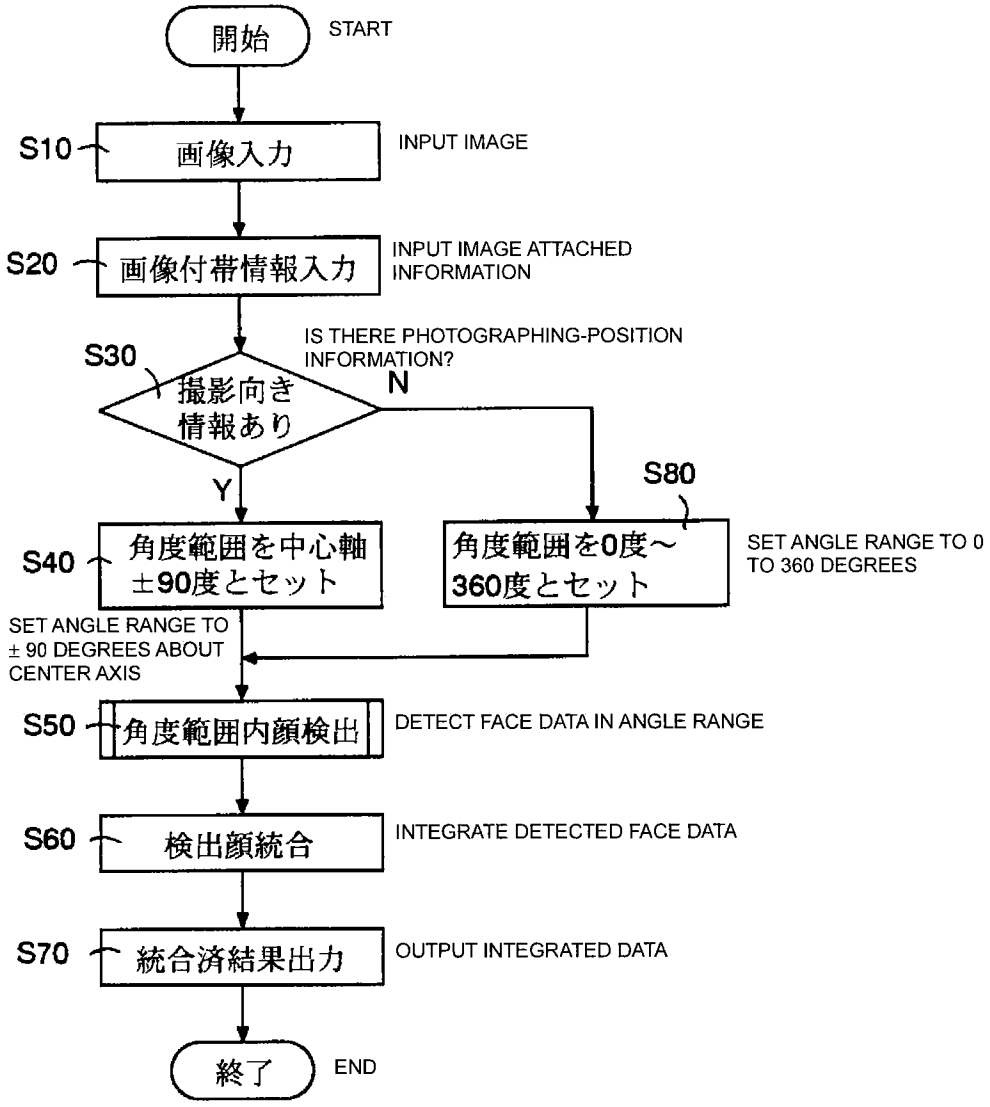
【図１】[FIG. 1]



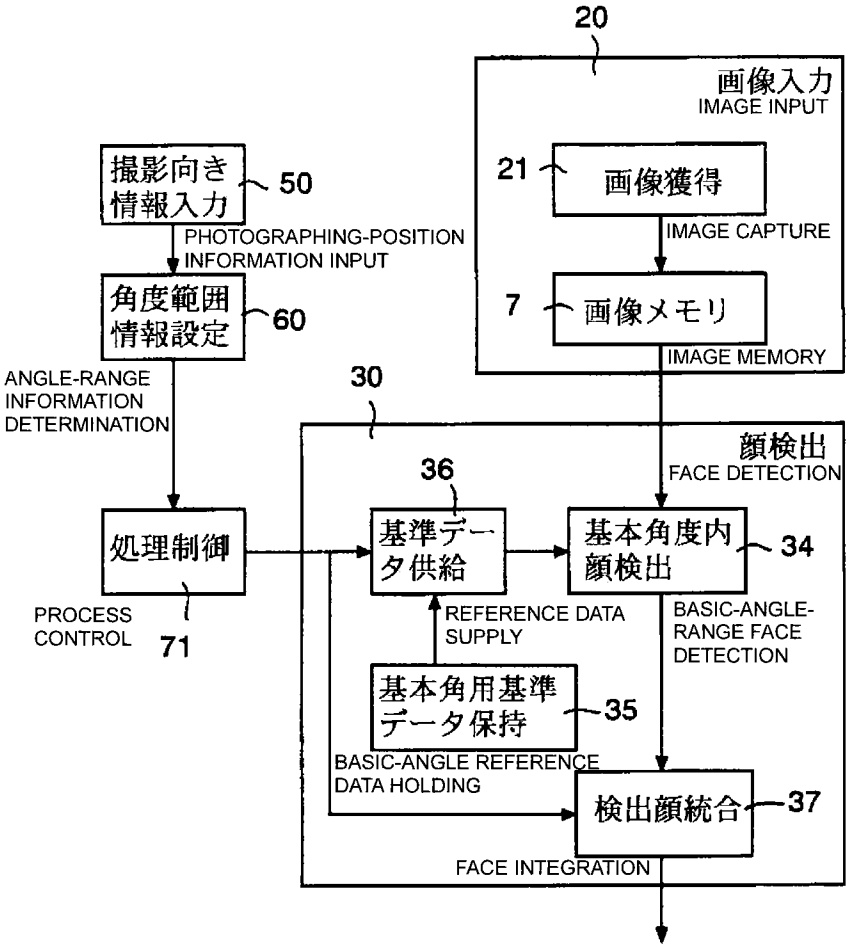
【図２】[FIG. 2]


12
撮像装置
IMAGING DEVICE
2
5
7
9
入力I/F
通信I/F
画像メモリ
画像メモリ
INPUT I/F
COMMUNICATION I/F
IMAGE MEMORY
1
出力I/F
CPU
RAM
ROM
I/O
OUTPUT I/F
3
6
8
10
4
プリンタ
PRINTER
HD
13
11

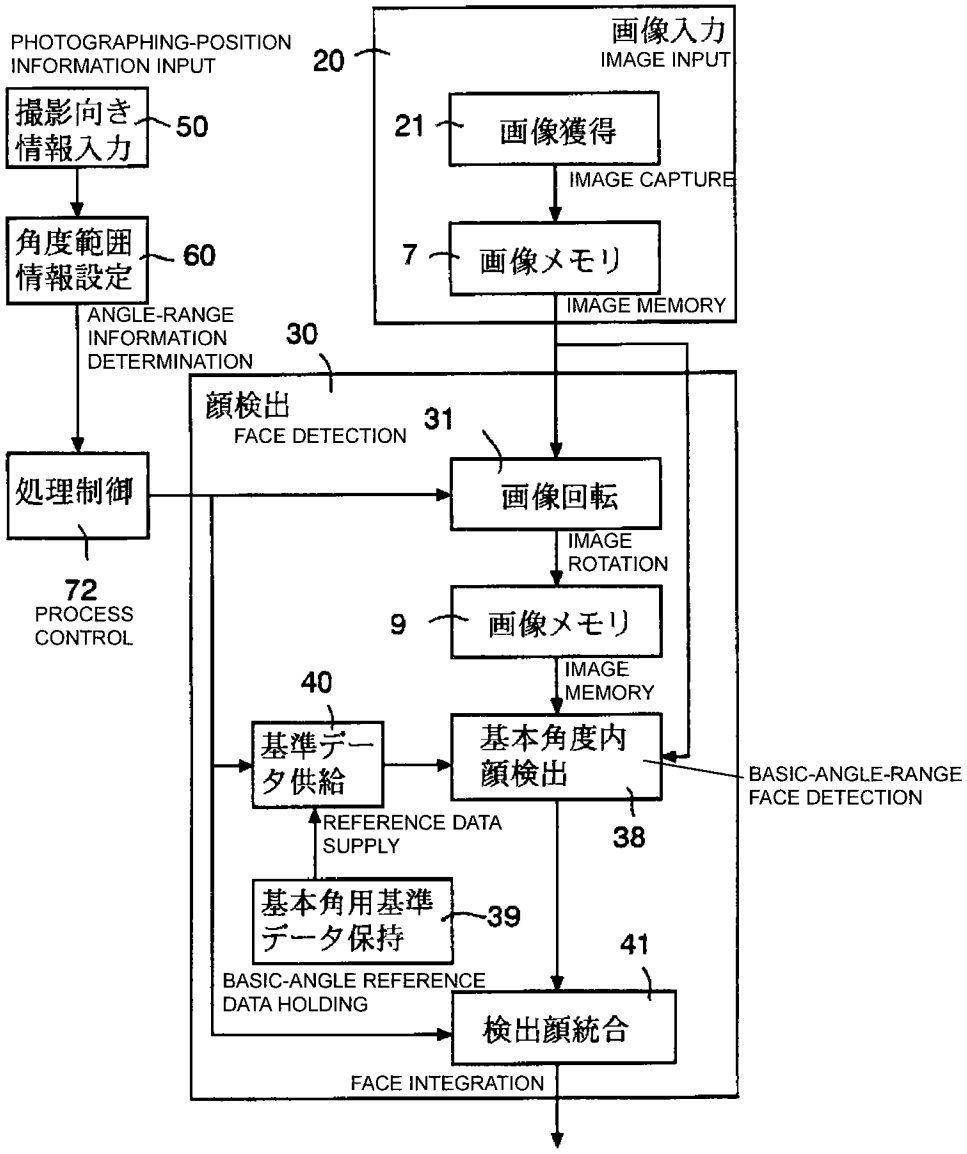
【図３】[FIG. 3]


開始
START
S10
画像入力
INPUT IMAGE
S20
画像付帯情報入力
INPUT IMAGE ATTACHED INFORMATION
S30
撮影向き情報あり
IS THERE PHOTOGRAPHING-POSITION INFORMATION?
N
Y
S80
角度範囲を0度～360度とセット
SET ANGLE RANGE TO 0 TO 360 DEGREES
S40
角度範囲を中心軸±90度とセット
SET ANGLE RANGE TO ± 90 DEGREES ABOUT CENTER AXIS
S50
角度範囲内顔検出
DETECT FACE DATA IN ANGLE RANGE
S60
検出顔統合
INTEGRATE DETECTED FACE DATA
S70
統合済結果出力
OUTPUT INTEGRATED DATA
終了
END

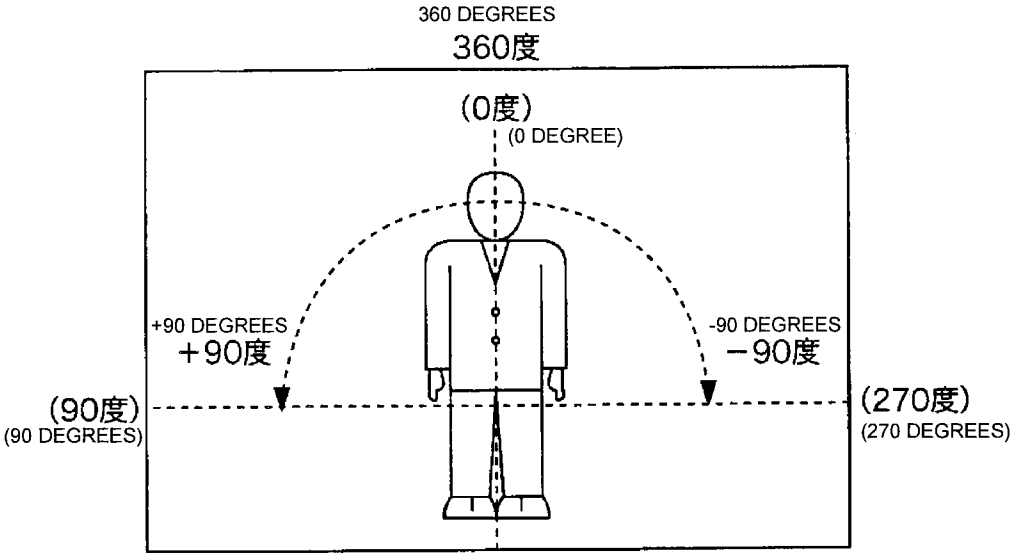
【図４】 [FIG. 4]


20
画像入力
IMAGE INPUT
21
画像獲得
IMAGE CAPTURE
7
画像メモリ
IMAGE MEMORY
撮影向き情報入力
50
PHOTOGRAPHING-POSITION INFORMATION INPUT
角度範囲情報設定
60
ANGLE-RANGE INFORMATION DETERMINATION
30
顔検出
FACE DETECTION
36
処理制御
基準データ供給
基本角度内顔検出
34
PROCESS CONTROL
71
REFERENCE DATA SUPPLY
BASIC-ANGLE-RANGE FACE DETECTION
基本角用基準データ保持
35
BASIC-ANGLE REFERENCE DATA HOLDING
検出顔統合
37
FACE INTEGRATION

【図５】[FIG. 5]

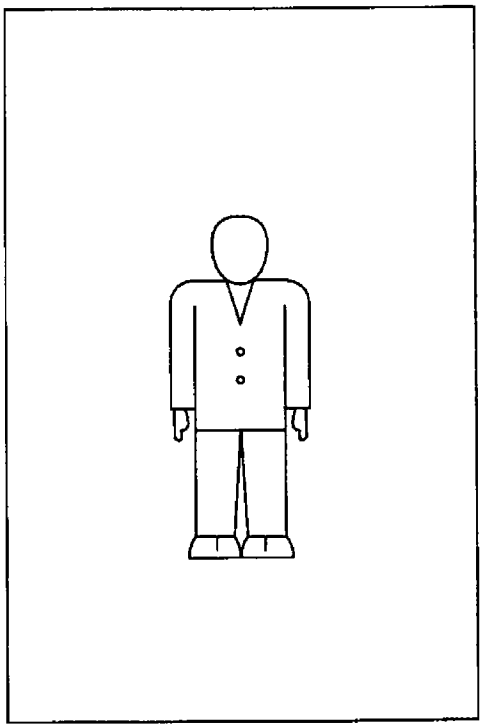

PHOTOGRAPHING-POSITION INFORMATION INPUT
撮影向き情報入力
50
角度範囲情報設定
60
ANGLE-RANGE INFORMATION DETERMINATION
処理制御
72
PROCESS CONTROL
20
画像入力
IMAGE INPUT
21
画像獲得
IMAGE CAPTURE
7
画像メモリ
IMAGE MEMORY
30
顔検出
FACE DETECTION
31
画像回転
IMAGE ROTATION
9
画像メモリ
IMAGE MEMORY
40
基準データ供給
基本角度内顔検出
BASIC-ANGLE-RANGE FACE DETECTION
38
REFERENCE DATA SUPPLY
基本角用基準データ保持
39
BASIC-ANGLE REFERENCE DATA HOLDING
41
検出顔統合
FACE INTEGRATION

【図６】[FIG. 6]

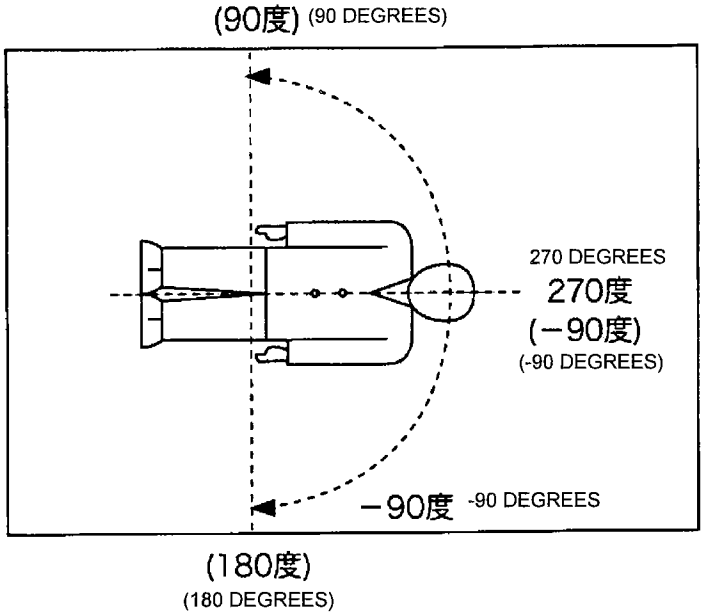

360 DEGREES
360度
(0度)
(0 DEGREE)
+90 DEGREES
+90度
-90 DEGREES
−90度
(90度)
(90 DEGREES)
(270度)
(270 DEGREES)

【図７】[FIG. 7]

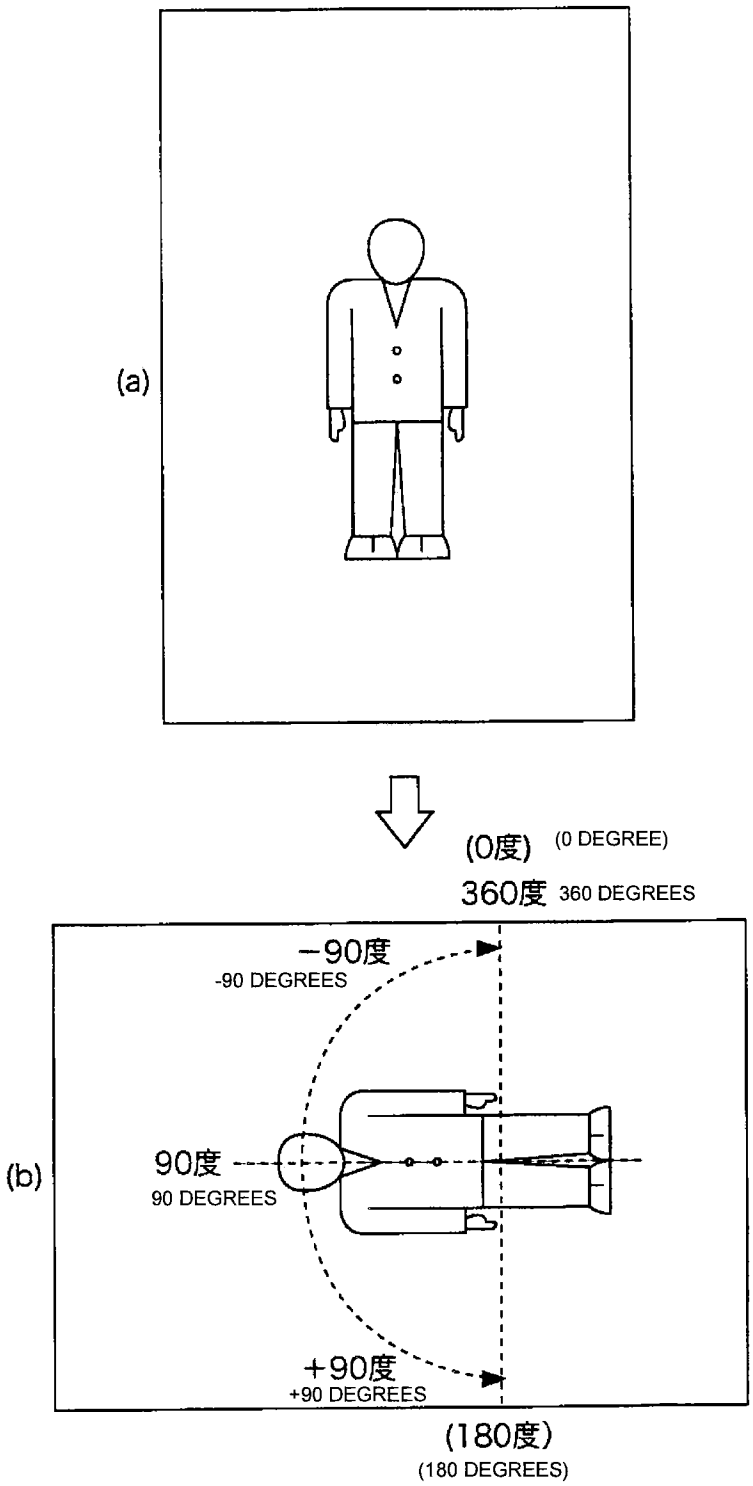
(a)



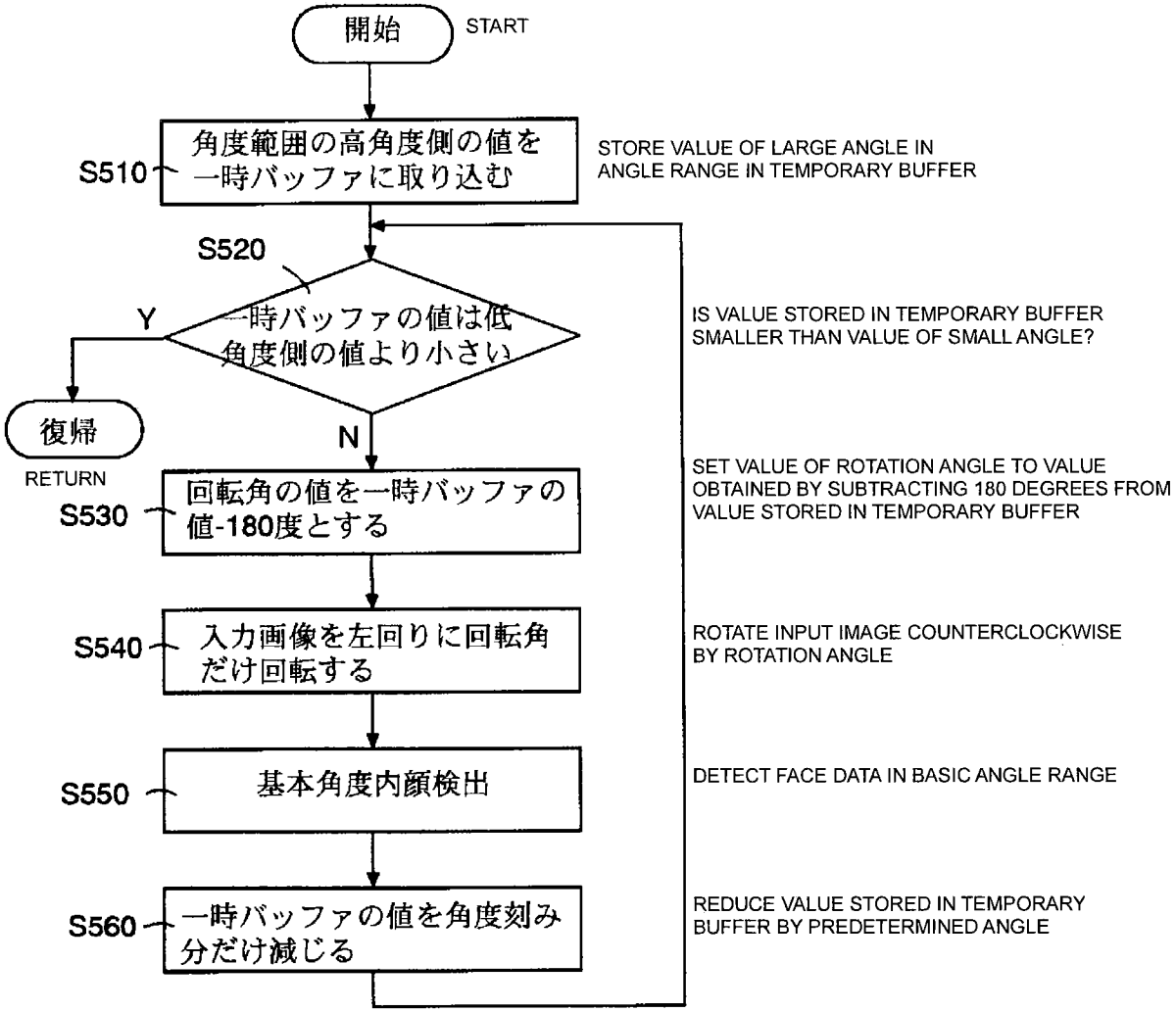
(b)


(90度) (90 DEGREES)
270 DEGREES
270度
(−90度)
(-90 DEGREES)
−90度 -90 DEGREES
(180度)
(180 DEGREES)

【図８】[FIG. 8]


(a)
(0度) (0 DEGREE)
360度 360 DEGREES
−90度
-90 DEGREES
(b)
90度
90 DEGREES
+90度
+90 DEGREES
(180度)
(180 DEGREES)

【図９】[FIG. 9]


開始
START
S510
角度範囲の高角度側の値を一時バッファに取り込む
STORE VALUE OF LARGE ANGLE IN ANGLE RANGE IN TEMPORARY BUFFER
S520
一時バッファの値は低角度側の値より小さい
IS VALUE STORED IN TEMPORARY BUFFER SMALLER THAN VALUE OF SMALL ANGLE?
Y
N
復帰
RETURN
S530
回転角の値を一時バッファの値-180度とする
SET VALUE OF ROTATION ANGLE TO VALUE OBTAINED BY SUBTRACTING 180 DEGREES FROM VALUE STORED IN TEMPORARY BUFFER
S540
入力画像を左回りに回転角だけ回転する
ROTATE INPUT IMAGE COUNTERCLOCKWISE BY ROTATION ANGLE
S550
基本角度内顔検出
DETECT FACE DATA IN BASIC ANGLE RANGE
S560
一時バッファの値を角度刻み分だけ減じる
REDUCE VALUE STORED IN TEMPORARY BUFFER BY PREDETERMINED ANGLE